STAV PUBLISHING

STAV Publishing 2006

Student name

BIOLOGY
Unit 4
Trial Examination

QUESTION AND ANSWER BOOK

Total writing time: 1 hour 30 minutes

Structure of book

Section	Number of questions	Number of marks
A	25	25
B	7	50
	Total	**75**

- Students are permitted to bring into the examination room: pens, pencils, highlighters, erasers, sharpeners and rulers.
- Students are NOT permitted to bring into the examination room: blank sheets of paper and/or white out liquid/tape.
- No calculator is allowed in this examination.

Materials supplied

- Question and answer book of 18 pages with a detachable answer sheet for multiple-choice questions inside the front cover.

Instructions

- Detach the answer sheet for multiple-choice questions during reading time.
- Write your **name** in the space provided above on this page and on the answer sheet for multiple-choice questions.
- All written responses should be in English.

At the end of the examination

- Place the answer sheet for multiple-choice questions inside the front cover of this book.

Published by STAV Publishing. STAV House, 5 Munro Street, Coburg VIC 3058 Australia.
Phone: 61 + 3 9385 3999 • Fax: 61 + 3 9386 6722 • Email: stav@stav.vic.edu.au Website: http://www.stav.vic.edu.au

ABN 61 527 110 823

STAV Publishing
2006

BIOLOGY
Unit 4 Trial Examination
MULTIPLE CHOICE ANSWER SHEET

STUDENT NAME:	

INSTRUCTIONS: **USE PENCIL ONLY**

- Write your name in the space provided above.
- Use a **PENCIL** for **ALL** entries.
- If you make a mistake, **ERASE** it – **DO NOT** cross it out.
- Marks will **NOT** be deducted for incorrect answers.
- **NO MARK** will be given if more than **ONE** answer is completed for any question.
- Mark your answer by placing a **CROSS** through the letter of your choice.

1.	A	B	C	D
2.	A	B	C	D
3.	A	B	C	D
4.	A	B	C	D
5.	A	B	C	D
6.	A	B	C	D
7.	A	B	C	D
8.	A	B	C	D
9.	A	B	C	D
10.	A	B	C	D
11.	A	B	C	D
12.	A	B	C	D
13.	A	B	C	D

14.	A	B	C	D
15.	A	B	C	D
16.	A	B	C	D
17.	A	B	C	D
18.	A	B	C	D
19.	A	B	C	D
20.	A	B	C	D
21.	A	B	C	D
22.	A	B	C	D
23.	A	B	C	D
24.	A	B	C	D
25.	A	B	C	D

SECTION A - Multiple Choice Questions

Specific instructions for Section A

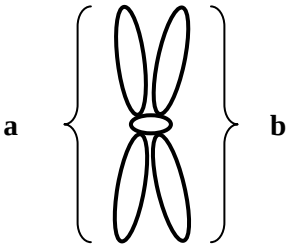
This section consists of 25 questions. You should attempt **all** questions.

Each question has four possible correct answers. Only **one** answer for each question is correct. Select the answer that you believe is correct and indicate your choice on the Multiple Choice Answer Sheet by crossing the letter that corresponds with your choice of the correct answer.

If you wish to change an answer, erase it and cross your new choice of letter.

Each question is worth **one** mark. **No** mark will be given if more than one answer is completed for any question. Marks will **not** be deducted for incorrect answers.

Question 1



In the diagram above of a chromosome:

A. **a** and **b** are chromatids each consisting of one DNA molecule
B. **a** and **b** are chromosomes each containing one DNA molecule.
C. **a** and **b** are chromatids each containing a single strand of DNA.
D. **a** and **b** are chromosomes each containing a single strand of DNA.

Question 2

The backbone of the DNA molecule is made up of:

A. phosphate molecules and ribose sugars.
B. deoxyphosphate molecules and ribose sugars.
C. phosphate molecules and deoxyribose sugars.
D. deoxyphosphate molecules and deoxyribose sugars.

Question 3

Mammalian sperm develop from cells known as primary spermatocytes that contain the same number of chromosomes as normal body cells. These primary spermatocytes divide to form secondary spermatocytes. A final division results in the formation of sperm. The relative amounts of DNA in each type of cell is shown in the table below.

Type of Cell	Relative mass of DNA
Primary spermatocyte	4
Secondary spermatocyte	2
Sperm cell	1

It is reasonable to state that:

A. the division from secondary spermatocyte to sperm cell represents the second meiotic division.
B. the division from primary spermatocyte to secondary spermatocyte involves mitosis.
C. the sperm cell contains ¼ of the total number of chromosomes for that organism.
D. the secondary spermatocyte is diploid.

Question 4

Coat colour of a short horned breed of cattle is an example of codominance.

Pure breeding red colour is represented by the genotype: $\mathbf{C^RC^R}$
Pure breeding white colour is represented by the genotype: $\mathbf{C^WC^W}$

When a pure breeding red bull is crossed with a pure breeding white cow they produce a roan coloured offspring represented by the genotype $\mathbf{C^RC^W}$.
If pure breeding red short horned bulls are crossed with roan cows, the theoretical percentage of offspring that will be roan would be:

A. 50%
B. 75%
C. 25%
D. 100%

Question 5

The alleles governing the M-N blood group system in humans are represented by the symbols $\mathbf{L^M}$ and $\mathbf{L^N}$. An agglutination test using anti-sera M and anti-sera N are used to determine the blood groups of individuals. The following three individuals were tested with the M and N anti-sera. A '+' denotes agglutination.

	Reaction with	
Individual	**Anti-sera M**	**Anti-sera N**
1	**+**	**–**
2	**+**	**+**
3	**–**	**+**

From this data it is possible to conclude that:

A. the genotype of individual 1 is **M**.
B. the genotype of individual 2 is $\mathbf{L^ML^N}$.
C. the genotype of individual 2 is **MN**.
D. the phenotype of individual 3 is $\mathbf{L^NL^N}$.

Question 6

Albinism or lack of pigmentation is a recessive condition found in humans. Two normally pigmented parents are heterozygous for albinism. The probability that they have an albino child would be:

A. 1/4
B. 1/16
C. 1/2
D. 0

Question 7

If these parents had two children, the probability of one child being albino and one being normally pigmented would be:

A. 1/2
B. 3/8
C. 1/16
D. 3/4

Question 8

In a population of laboratory mice white colour is recessive to brown. A large population of these mice that consisted of 47% white and 53% brown were allowed to breed randomly for several generations. After several generations of breeding the population still showed the same percentages of 47% white and 53% brown.
From this data it would be reasonable to conclude that:

A. the heterozygous phenotype is lethal.
B. the population is undergoing genetic drift.
C. selection has favoured the recessive allele.
D. the two phenotypes are selected for equally under laboratory conditions.

Questions 9 to 11 refer to the following information.

A student planted 100 seeds of barley that had been produced by cross pollinating 2 green barley plants. Fifty of these seeds were incubated at 30 °C in the dark and fifty were incubated at 30 °C in the light. Of the fifty seeds that were grown in the dark all fifty plants were white whereas of the fifty plants grown in the light 78% were green and the rest were white.

Question 9

The seedlings grown in the dark all being white is an example of:

A. the environment influencing the phenotype.
B. the environment influencing the genotype.
C. the phenotype influencing the environment
D. the genotype influencing the environment.

Question 10

The genotypes of the original barley plants were:

A. one homozygous for chlorophyll formation and one heterozygous for chlorophyll formation.
B. both homozygous for chlorophyll formation.
C. one homozygous for chlorophyll formation and the other homozygous for no chlorophyll formation.
D. both heterozygous for chlorophyll formation.

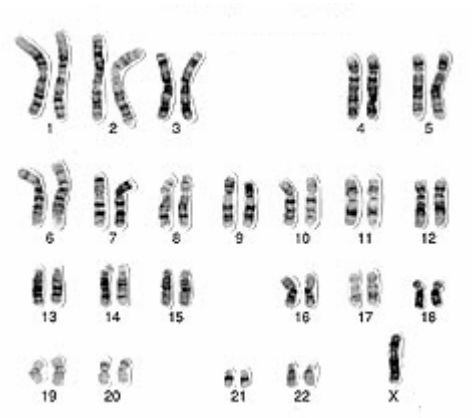
Question 11

The student separated all the plants grown in the light and decided to raise a pure breeding line of white plants by growing these plants to maturity and cross pollinating them for seeds. This exercise would be:

A. possible because the white plants are all homozygous.
B. possible because all the white plants would all grow in the dark.
C. impossible because the white plants could not reach maturity to form seeds.
D. impossible because the white plants were heterozygous and therefore would not form a pure breeding line.

Question 12

The diagram below represents an abnormal human karyotype.



The abnormal karyotype above is most likely to have resulted from:

A. polyploidy during gamete formation.
B. gene mutation in the germ cells.
C. non crossing over during gamete formation.
D. non-disjunction during gamete formation.

Question 13

A segment of DNA is 5'ATC GAT TAG 3'. The mRNA that would be coded for from this DNA template would be:

A. 3'ATC GAT TAG 5'
B. 3'CUA AUC GAU 5'
C. 3'UAG CUA AUC 5'
D. 3'TAG CTA ATC 5'

Question 14

DNA profiling is a technique used by scientists to identify DNA from different individuals. Part of the process of DNA profiling is to use gel electrophoresis. Gel electrophoresis is used to:

A. cut DNA into fragments.
B. separate fragments of DNA according to size.
C. make multiple copies of DNA fragments.
D. match fragments of DNA with their function.

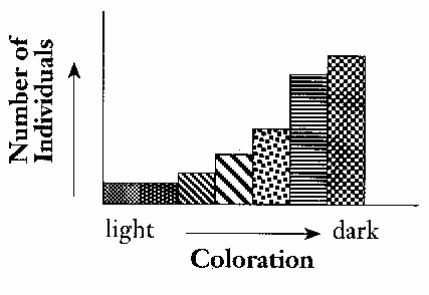
Question 15

A phenotype shown by humans is height. Sometimes two tall parents can produce a shorter than normal child. This is most likely because:

A. human height is an example of polygenetic inheritance.
B. human height is an example of discontinuous variation.
C. human height is an example of X linkage.
D. human height is an example of genetic drift.

Question 16

Scientists were investigating a group of land snails found in a remote area seldom visited by humans. The scientists observed a range of snail colours ranging from light to dark. After sampling the data they presented it as the graph below.



From this data it would be fair to say that this snail population was undergoing:

A. stabilizing selection.
B. artificial selection.
C. disruptive selection.
D. directional selection.

Question 17

In the nineteenth century the rate of deafness on Martha's Vineyard (an island off the coast of Massachusetts USA) was 30 times that of the mainland population. Martha's Vineyard was settled by a small group of English families in around 1700.
This is an example of:

A. natural selection.
B. gene flow.
C. selective advantage.
D. the founder effect.

Question 18

DNA can be permanently altered by the action of ultraviolet light. Ultraviolet light in this context is:

A. a mutagen.
B. a photon.
C. a receptor.
D. a reactant.

Question 19

Drug resistance in disease causing bacteria is a big problem especially in the hospital environment. Drug resistant mutations occur in bacteria:

A. only when bacteria are exposed to the drug.
B. more often when bacteria are exposed to the drug.
C. at any time even when the bacteria are not exposed to the drug.
D. only when the bacteria are also exposed to mutagens.

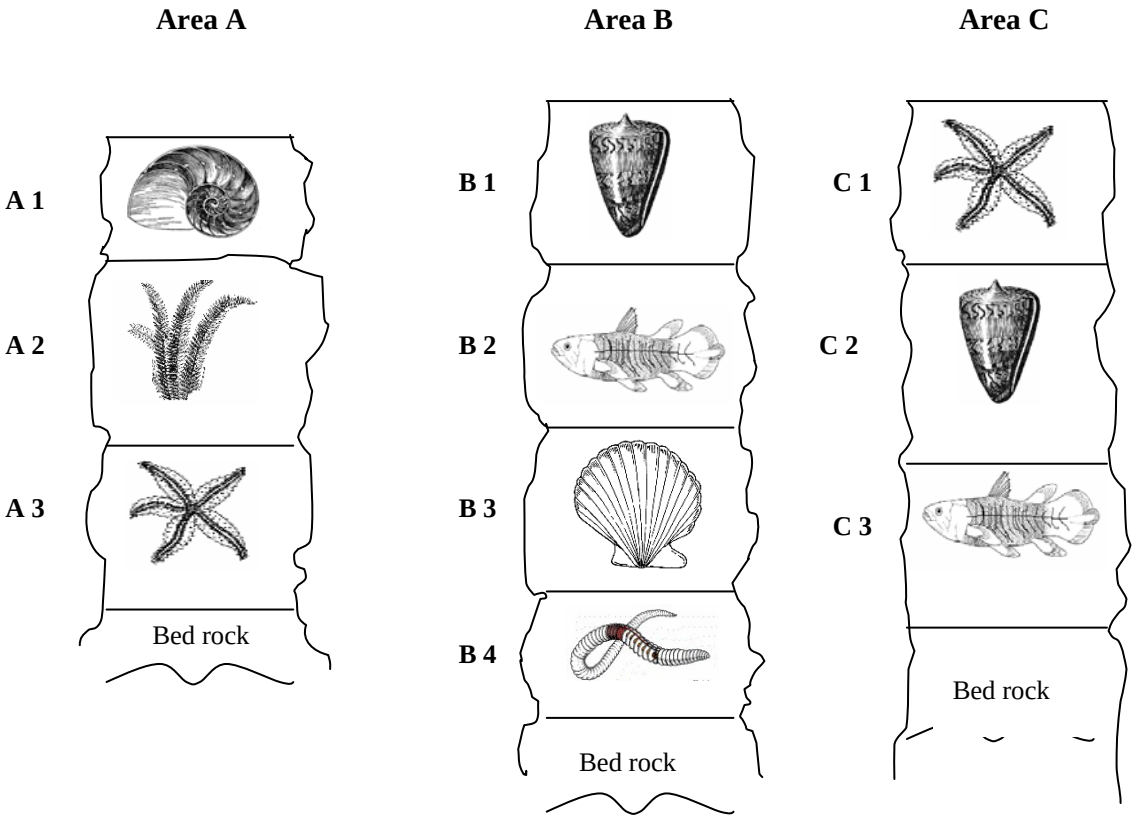
Question 20

The process acting on genetic variability leading to change is:

A. mutation.
B. natural selection.
C. random mating.
D. evolution.

Question 21

The diagrams below represent sedimentary rock strata from three different areas.



The oldest layer represented would be:

A. **C 1**
B. **A 3**
C. **B 1**
D. **B 4**

Question 22

In order to obtain an idea of the absolute age of fossils scientists can use radioactive dating. One radioactive element used is uranium-235. This element has a half-life of about 700 million years. When the rock form containing fossils was tested for uranium it was found to only have 1/32 of the original uranium-235 present. This meant that the approximate age of the fossil would be:

A. 3500 million years old.
B. 22400 million years old.
C. 35 million years old.
D. 32 million years old.

Question 23

A small population of frogs lives on an island that was once connected to the mainland. Over many generations several alleles have completely disappeared from the island population although they are still present on the mainland. These alleles have most probably disappeared due to:

A. a high rate of mutation.
B. non random mating.
C. genetic drift.
D. gene flow.

Question 24

The most popular theory of the evolution of humans is that they originated in Africa and migrated from there to other parts of the world. This is the "Out of Africa hypothesis". The other view is that modern humans evolved in different parts of the world from populations of *Homo erectus*. This is the "Parallel evolution or regional continuity hypothesis". Recent studies of mitochondrial DNA (mtDNA) tend to support the "Out of Africa hypothesis". The mtDNA evidence that would support this theory would show:

A. variation in mtDNA to be greater in African populations than in populations outside Africa.
B. variation in mtDNA to be the same in all populations throughout the world.
C. variation in mtDNA to be greatest in populations outside Africa and less among African populations.
D. no variation in mtDNA as the human populations all belong to the genus *Homo*.

Question 25

Humans are undergoing both cultural and biological evolution. It is reasonable to state that:

A. the rate of cultural evolution is slower than biological evolution as cultural evolution involves learning whereas biological evolution is out of our control.
B. the rate of biological evolution is much slower than cultural evolution as it relies on mutations and natural selection.
C. the rate of cultural evolution and biological evolution are the same as they both involve passing changes from one generation to the next.
D. modern man is able to control both his biological and cultural evolution due to modern technology.

END OF SECTION A

SECTION B - Short Answer Questions

Specific instructions for Section B

This section consists of 7 questions. There are 50 marks in total for this section.
Write your responses in the spaces provided. You should attempt **all** questions. Please write your responses in **blue** or **black ink**.

Question 1

In mice, a gene governing tail shape has the following alleles:

K for a kinky tail **k** for a normal tail

a What would be the genotype of a mouse with a normal tail?

_____

(1 mark)

Another unlinked gene is responsible for coat colour. This gene has the alleles **A** and $\mathbf{A^Y}$. A mouse that has the genotype **AA** is a grey colour and a mouse that has the genotype $\mathbf{AA^Y}$ is yellow. The genotype $\mathbf{A^YA^Y}$ is lethal, that is the mice die before birth.

b What is meant by the term unlinked genes?

_____

(1 mark)

c A scientist studying lethality in mice crossed two yellow mice that were heterozygous for kinky tails. Using the appropriate symbols show the genotypes of the parents.

Parents' phenotype **Yellow with a kinky tail** **Yellow with a kinky tail**

Parents' genotype _____ **X** _____

(1 mark)

d In the space below, use a punnet square to determine the theoretical ratio of possible phenotypes expected from this cross.

Possible phenotypes and their ratios:

_____

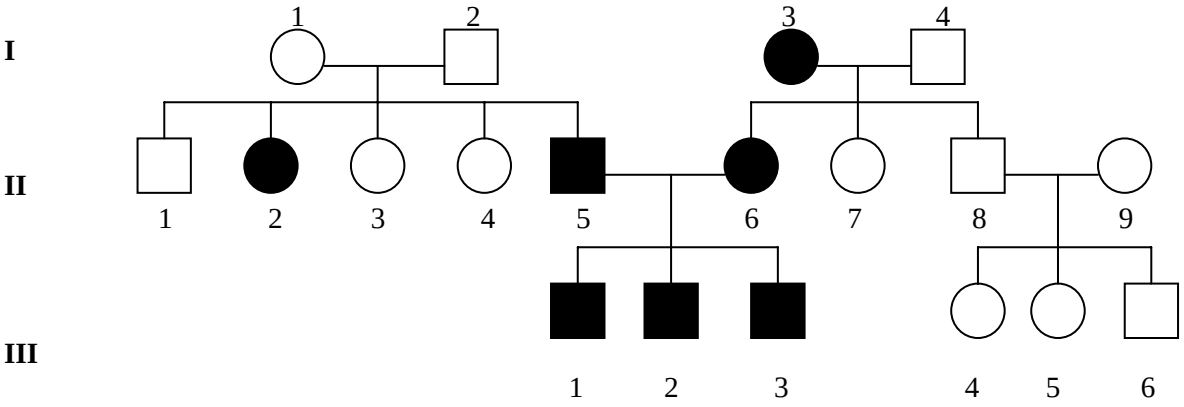
_____

(4 marks)

Total 7 marks

Question 2

The pedigree below shows the inheritance of a condition called galactosaemia in which the individual is unable to metabolise galactose, the sugar found in milk. Shaded individuals show the trait.



a What type of inheritance is shown here? Support your answer by referring to the pedigree.

_____

_____

_____

_____

(2 marks)

b Which individual(s) **must** be heterozygous in the pedigree?

_____

(1 mark)

c What is the probability that individual **II** 3 is heterozygous?

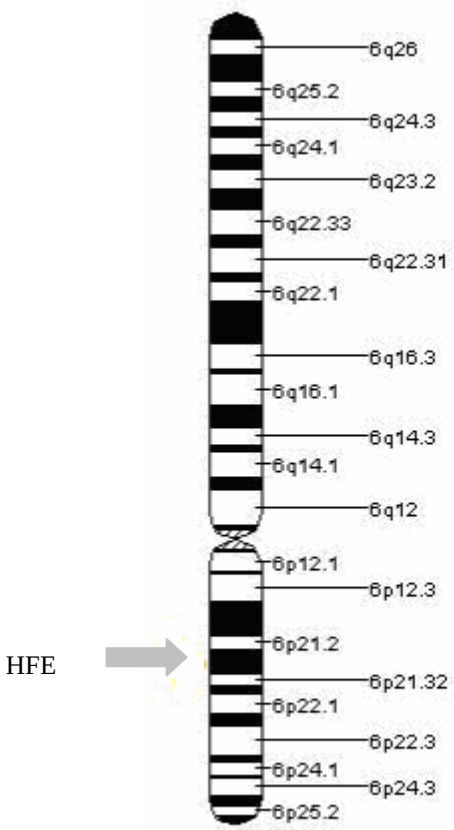
_____

(1 mark)

Total 4 marks

Question 3

The HFE gene, present on chromosome 6, controls the formation of a protein on the cell surface.



This transmembrane protein, expressed in intestinal and liver cells, works in conjunction with other smaller proteins to regulate iron uptake from food during digestion. If this protein is working normally the body absorbs about 10% of the total iron intake. Mutations in the HFE gene result in the inherited condition Haemochromatosis. The body as a result of this mutation absorbs and stores too much iron. If the disease is not detected early enough, iron will accumulate in body tissues leading to serious health problems. The most common mutation is C282Y affecting 1 in 300 with most people being of European or Anglo-Saxon descent. Heterozygotes for this mutation do not usually show symptoms of the condition.

a What type of inheritance is Haemachromatosis? Give reasons for your answer.

_____

_____

(2 marks)

The HFE gene has seven coding regions interspersed with segments of non-coding regions.

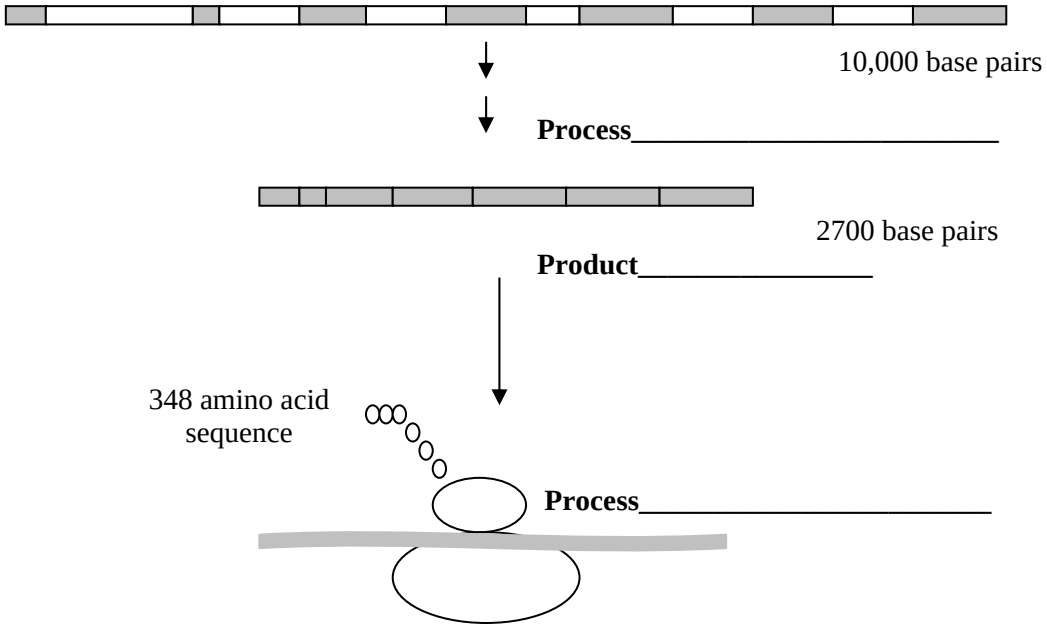
b What term is given to the

Non-coding regions_____

Coding regions _____

(2 marks)

c The following diagram outlines the steps from gene to protein product. Label each of the processes and product in the spaces provided.



(3 marks)

The most common mutation responsible for hereditary Haemochromatosis is the replacement of the amino acid cysteine at position 282 in the peptide chain by the amino acid tyrosine.
Part of the amino acid chain is shown below for the normal chain and the mutated chain.

Amino acid number	280	281	282	283	284
Normal peptide	Tyrosine	Threonine	Cysteine	Glutamine	Valine
Peptide with mutation	Tyrosine	Threonine	Tyrosine	Glutamine	Valine

The following table gives the mRNA codons for the amino acids.

The Genetic Code for RNA codons to amino acids.

First Base Letter	Second base letter: U	Second base letter: C	Second base letter: A	Second base letter: G	Third Base Letter
U	Phenylalanine Phenylalanine Leucine Leucine	Serine Serine Serine Serine	Tyrosine Tyrosine ***Stop*** ***Stop***	Cysteine Cysteine ***Stop*** Tryptophan	**U** **C** **A** **G**
C	Leucine Leucine Leucine Leucine	Proline Proline Proline Proline	Histamine Histamine Glutamine Glutamine	Arginine Arginine Arginine Arginine	**U** **C** **A** **G**
A	Isoleucine Isoleucine Isoleucine Methionine	Threonine Threonine Threonine Threonine	Asparagine Asparagine Lysine Lysine	Serine Serine Arginine Arginine	**U** **C** **A** **G**
G	Valine Valine Valine Valine	Alanine Alanine Alanine Alanine	Aspartic acid Aspartic acid Glutamic acid Glutamic acid	Glycine Glycine Glycine Glycine	**U** **C** **A** **G**

d Using this table deduce a DNA triplet that would code for Tyrosine.

_____

(1 mark)

e (i) What is the simplest change in the DNA triplet that could result in this mutation?

_____

(ii) What type of mutation is this called?

_____

(1 + 1 = 2 marks)

As a result of this mutation the HFE protein is not incorporated into the cell membrane. The cell therefore becomes iron-overloaded because there is no HFE protein to regulate the iron flow.

f Suggest why replacing one amino acid with another could prevent the HFE protein from being incorporated into the cell membrane.

_____

_____

_____

_____

_____

(2 marks)

Haemochromatosis can be tested for in patients showing symptoms of iron-overload. The DNA is extracted from a blood sample and is subjected to allele specific PCR. Primers are used for the PCR that are specific for the allelic variants for Haemochromatosis.

g What do the letters PCR stand for?

_____

(1 mark)

The DNA formed in the PCR reaction is heated and treated with specific probes for the mutated HFE gene and incubated. An anti-monoclonal antibody that binds only with double helix DNA is added and the mixture is again incubated. Finally the preparation is examined to determine if the anti-monoclonal antibody has bound or not. Diagnosis is then made.

h What result would give a positive diagnosis for Haemochromatosis? Explain your answer.

_____

_____

_____

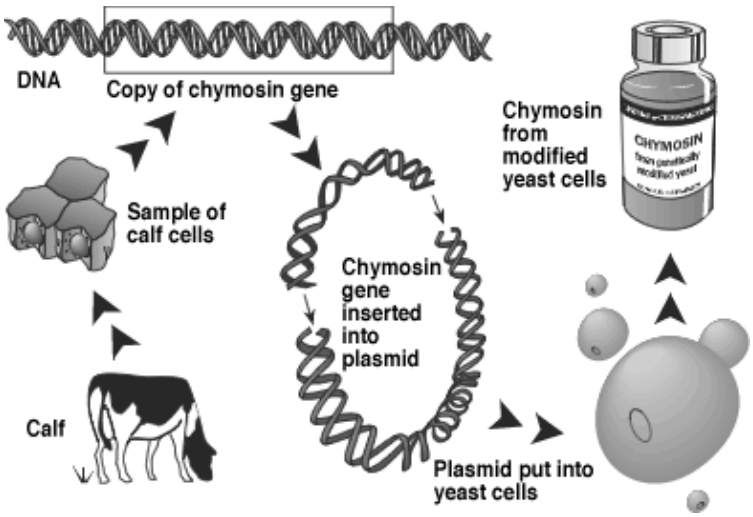
_____

(2 marks)

Total 15 marks

Question 4

Chymosin is a protease enzyme used in cheese making. This enzyme used to be extracted from calves' stomachs. Today about 90% of hard cheese is made using chymosin from genetically modified micro-organisms. These enzymes behave exactly the same way as chymosin from calves.
The diagram below outlines the process of manufacture of chymosin in yeast cells. These yeast cells are grown in a fermenter vessel and produce the enzyme chymosin that is then used in cheese making. Like all enzymes, only a very small amount is needed for cheese production. The enzyme is unstable and breaks down as the cheese matures.



In order to insert the chymosin gene the plasmid must be cut and then joined up again.

a What is a plasmid?

_____

_____

(1 mark)

b What is used to cut the DNA ?

_____

(1 mark)

c What is used to join the pieces of DNA together?

_____

(1 mark)

Cheese made using chymosin from genetically modified yeast is labeled GMO free.

d Can the cheese be labeled GMO free? Explain.

_____

_____

_____

_____

(2 marks)

There is strong debate in Australia and elsewhere about genetically modified (GM) crops. Some genetically modified crops have a herbicide resistant gene inserted so that the farmer can spray the crop with weed killers without affecting the crop plants themselves. It is important that when trial GM crops are planted there is a wide buffer zone between GM crop farms and farms that grow the same crop that are not GM plants.

e Why is it necessary to have a buffer zone between farms?

_____

_____

_____

(1 mark)

Total 6 marks

Question 5

Pictured below are two plants.

The one on the left is a true cactus, family *Cactaceae* from North America. The one on the right belongs to the family *Euphorbiaceae* from Africa.

a Name two features that these two plants have in common.

_____

_____

(2 marks)

b What type of evolution best describes the evolution of these two plants?

_____

(1 mark)

c Explain how you came to your answer in **b**.

_____

_____

(1 mark)

d Are the features you described in **a** above homologous or analogous? Explain your answer.

_____

_____

_____

_____

(2 marks)

Chloroplast DNA (cpDNA) sequencing is a useful tool in the study of the relatedness of different plant species. Chloroplast DNA exists as a single circular chromosome in the chloroplast. There are many cpDNA molecules in each chloroplast and there are many chloroplasts per plant cell. Chloroplasts reproduce asexually and inheritance is from one parent only.

e Why would cpDNA be preferred in such a study rather than nuclear DNA?

_____

_____

_____

_____

(2 marks)

Total 8 marks

Question 6

The table below shows the differences between various primates and the amino acid sequences in the β chain of their haemoglobin when compared to humans.

	human	chimpanzee	gorilla	gibbon	old world monkey	new world monkey	lemur
human		0	1	2	8	8	25
chimpanzee			1	2	8	8	25
gorilla				3	7	9	24
gibbon					6	6	23
old world monkey						11	22
new world monkey							25
lemur							

a Based on the information in this table which primate is the closest relative to humans? Justify your choice.

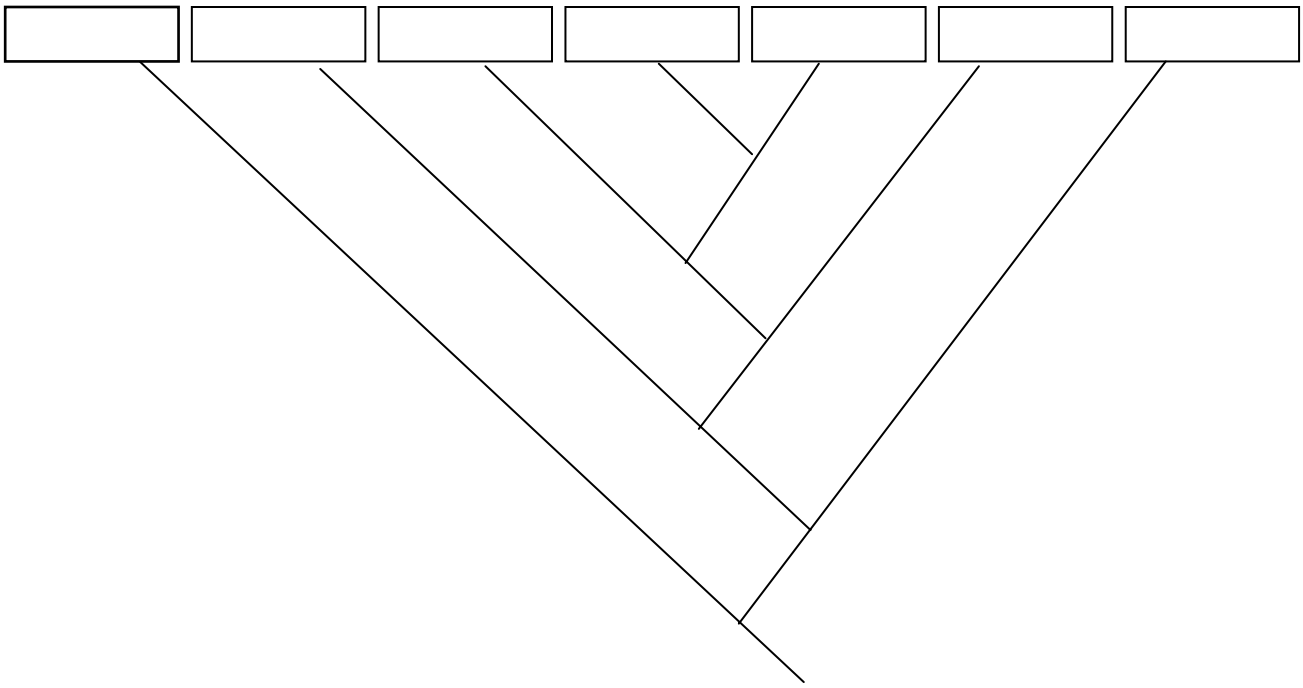
_____

_____

_____

(1 mark)

b Using the data from this table complete the cladistic tree below by writing the appropriate animal from the table in the boxes below.



(2 marks)

c Name and describe another technique that can be used to determine evolutionary relationships between primates.

_____

_____

_____

_____

(2 marks)

Humans have other physical features that distinguish them from chimpanzees and gorillas.

d Name **two** of these features and their selective advantages.

(i) Feature _____

Selective advantage _____

_____

_____

(ii) Feature _____

Selective advantage _____

_____

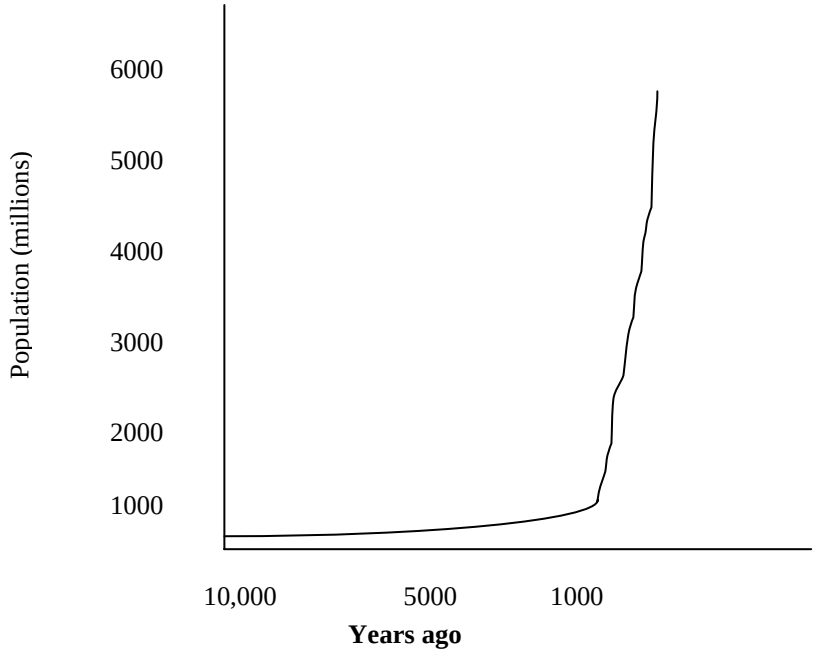
_____

(2 marks)

Total 7 marks

Question 7

The population of humans has been growing exponentially since the late 1800s and has risen very sharply as the graph below depicts. The human population has increased more in the last 70 years than at any other time in human history, reaching 6.5 billion (6500 million) in February 2006.



a Suggest one reason for the gradual increase in population depicted on the graph between 10,000 and 1000 years ago.

_____

_____

(1 mark)

Many people believe that humans can now control their own evolution.

b Outline one way that advances in medicine and /or technology have or can contribute to human evolution.

_____

_____

_____

_____

_____

(2 marks)

Total 3 marks

END OF EXAMINATION

Acknowledgements
Section A Q 21 diagram sourced from: SciArt The New Millenium CD, Cambridge University Press
Websites: http://gslc.genetics.utah.edu/units/disorders/karyotype/turnersyndrome.cfm
http://ghr.nlm.nih.gov/gene=hfe;jsessionid=BD5954DC78DDC3CB9632C99164F
http://www.ncbe.reading.ac.uk/NCBE/GMFOOD/chymosin.html
http://userwww.sfsu.edu/~biol240/labs/lab_01variation/pages/1var_among.html